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Article

Influence of Tropical Weather and Northeasterly Air Mass on Carbonaceous Aerosol in the Southern Malay Peninsula

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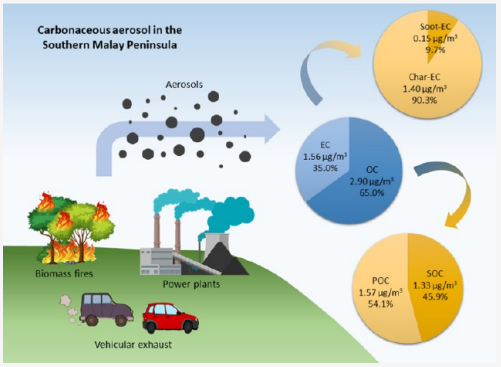
ABSTRACT: Carbonaceous aerosols play a key role in climate modification and exert a deleterious effect on human health. Thus, this study aimed to determine the thermally derived carbonaceous fraction in particulate matter $(PM)_{2.5}$ from the Southern Malay Peninsula, a tropical area in Malaysia, during January 2019 to March 2019. $PM_{2.5}$ was captured on quartz filters using a high-volume sampler on a 24 h basis. Eight of the carbon fractions were measured using the thermal optical reflectance method. Carbonaceous aerosol was thoroughly characterized by estimating elemental carbon (EC), organic carbon (OC), total carbon, secondary OC, soot-EC, and char-EC to determine the mechanism of emission from fossil fuel combustion, biomass, and secondary origins. The effect of local meteorological factors and air mass transport on the change in the light-absorbing aerosol fraction was also examined. Secondary organic sources and primary sources emitted 46 and 54% of OC, respectively. The estimated char-EC in this study was 10-fold higher than soot-EC, indicating that biomass burning and coal combustion were the predominant routes of EC emission, whereas petrol or diesel engines were the less predominant generators of soot-EC. Trajectory modeling showed that biomass fires in the Indochina region were the potential origin of carbonaceous aerosols transported from the northeasterly direction.



KEYWORDS: *thermally derived light-absorbing aerosol, $PM_{2.5}$, northeasterly monsoon, elemental carbon, backward trajectory*

1. INTRODUCTION

Air pollution caused by the presence of particulate matter (PM) has become a serious environmental problem in many parts of the world, including tropical Southeast Asia.[1−5] Air pollution due to biomass and peat-soil burning and forest fires in Southeast Asia exerts deleterious effects on human health and the economy. Several studies have demonstrated that equatorial biomass burning caused a huge number of deaths in 2015, 2013, 2006, and 1997.[6−12] The majority of countries, especially those with urban areas, in Southeast Asia, encounter high levels of air pollution with annual mean levels that often surpass World Health Organization (WHO) limits.[13] Pollutants mainly originate from industries, coal power plants, biomass burning, automobiles, and household solid fuel usage.[14−16] The fine PM fraction with an aerodynamic diameter of less than 2.5 μm ($PM_{2.5}$) has become a great concern because it can affect visibility,[17] induce changes in the global climate due to its capability to absorb and scatter solar radiation,[18,19] and cause serious health effects in the human population.[20−22] Moreover, $PM_{2.5}$ has a damaging effect on human health due to its capability to penetrate deep into the lungs and cardiovascular system. Specifically, this effect gives rise to diseases, including short- and long-term respiratory problems (e.g., coughing, asthma, and lung cancer);[23−28] increases mortality related to cardiovascular diseases (heart diseases and heart rate variation);[5,24,29−38] causes Alzheimer's or neurological dementia;[39−42] and exacerbates the possible airborne transmission of COVID-19,[43−50] which has caused a global pandemic.

Carbonaceous aerosols are a significant component of $PM_{2.5}$ and account for 40% of $PM_{2.5}$ in the urban atmosphere.[51] They are mainly composed of organic carbon (OC) and elemental carbon (EC). EC is well recognized as a refractory light-absorbing fraction of aerosol and plays an important role in climate modification.[52] It degrades air quality, thus reducing visibility; acts as a precursor to haze evolution; and influences the oxidative potential of aerosol particles.[53] OC is directly derived from primary sources, such as fossil fuel combustion and biomass burning, or produced from secondary atmospheric chemical reactions or precursor volatile organic compounds emitted from biogenic sources, whereas EC is

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